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SCIENCE AND TECHNOLOGY IN AUSTRALIA

This article has been contributed by the Commonwealth Scientific and Industrial Research Organisation - written by Graeme O'Neill.

Several lines of evidence indicate that by 60,000 years ago, a coastal culture from the Indonesian archipelago developed a sailing craft capable of undertaking short ocean voyages. From this culture came the ancestors of Australia's Aboriginals. Uniquely, the colonisation of Australia demanded the use of maritime technology - the world's other inhabited continents were all colonised via overland routes. No direct overland connection has ever existed between Australia and the Indonesian archipelago; the smallest gap even at times of low sea level was at least 70 kilometres. Thus, the presence of humans in Australia some 50-60,000 years ago can only be explained by their use of boats or rafts.

In time, these early marine technologists made a successful transition to a hunter-gatherer existence, and developed a unique hunting weapon, the boomerang, with aerodynamic principles that anticipated the curved aerofoil wing that millennia later would permit man himself to take to the air. Aboriginal technologists also developed the woomera, a mechanical throwing device based on the lever, which enabled a spear to be thrown with much greater force and accuracy than by the human arm alone. They also developed tools for making fire at will, and employed fire to modify the environments in which they hunted, and as an aid to hunting itself. And although Aboriginal cultures never studied their environments in a scientific sense, they understood the world around them with an intimacy that has not yet been achieved by formal scientific study.

Australia's geographic isolation and harsh environment demand innovation; the technological achievements of the continent's original colonisers were an impressive response to adversity. It cannot be claimed that innovation began with the arrival of the continent's first European colonists 200 years ago; the scientific and technological achievements of Australians during those two centuries must be seen as part of a 60,000 - year continuum of human progress, impelled by isolation and environmental adversity.

Indeed, the efforts of Australia's first British colonists to transplant agricultural systems evolved for temperate Europe's climate and fertile soil proved a failure in the warmer, drier climate and poor soils of the Hawkesbury region. English winter wheats were poorly adapted to such conditions and susceptible to disease, and yields were poor. The wheat industry, which today dominates Australian agriculture, limped on throughout the greater part of the 19th century. It took an historic confluence between a scientific revolution and a scientific genius in the 1880s to

establish it as a major force in the Australian economy. Amid scepticism from his peers and the community, William Farrer, former Oxford mathematics wrangler, showed that systematic breeding principles could be applied to improving and adapting wheat to Australian conditions. Farrer bred rust-resistant varieties, but his more important achievement was to develop earlier-maturing varieties like 'Federation' which, by avoiding the worst heat of summer, enabled the wheat industry to expand out of the cooler, wetter highlands into the broad, drier plains of the inland. By the second decade of the 20th century, the wheat industry was booming. Although the genetic legacy of Farrer's wheats has been diluted, the systematic, scientific approach to breeding, which he was among the first in the world to exploit, remains his monument. It set a pattern for wheat breeding that is still used in Australia's wheat breeding institutions today.

Australia's other great agricultural industry, wool-growing, had its genesis soon after the founding of the colony. Captain John Macarthur, the Reverend Samuel Marsden, William Cox and Alexander Riley imported a number of Spanish Merino sheep. Macarthur and Marsden were probably the most prominent figures in developing an improved merino strain yielding an exceptionally fine, high-quality wool. The wool industry boomed. By the early 1890s, sheep numbers had reached a peak of 100 million but then went into sharp decline, particularly in drier regions, due to the impact of overgrazing on native pastures, drought and competition from introduced rabbits. Australian scientists have continued to grapple with these problems during the 20th century with mixed success.

Innovation in Australia during the 19th century was largely the domain of the individual; given the central importance of agriculture, grazing and minerals - chiefly gold - to the colony's economy, it was in these areas that Australians displayed their greatest inventiveness.

Some inventions were bizarre, others highly practical. The stump-jump plough, invented by Robert and Clarence Smith in 1876, enabled cultivation of mallee lands that had previously proved untillable because of the huge sub-surface mallee roots left after surface growth had been removed.

In 1877, Frederick Wolseley patented on the world's first mechanical shearing equipment, whose basic design still endures in modern shearing sheds. Another durable invention was James Alston's unique Australian windmill, used to pump artesian water for livestock in arid areas.

In 1884, 19 year old Hugh McKay demonstrated a prototype of his wheat stripper - harvester, which became the first commercially successful machine capable of stripping, threshing, cleaning and bagging wheat in one continuous operation. By 1902 McKay was exporting harvesters, mainly to Argentina.

In the 1890s, Christian Koerstz developed a cheap wool press which could be operated by two men, allowing even small graziers to build their own wool sheds, where previously they had taken their sheep to large landholders for shearing.

The same year saw Australian veterinary scientists develop a vaccine against anthrax after a successful visit by one of Louis Pasteur's staff - an early example of the extensive international exchanges that have so benefited 20th century Australian science and technology.

Australian research during the 19th century was focused on the natural sciences. The richness of Australia's unique flora and fauna was hinted at by the first formal collections of plants, animals and insects by Joseph Banks and Daniel Solander, naturalists with Captain James Cook's **Endeavour** expedition to the east coast in 1770. This was confirmed by a succession of explorer-naturalists and botanists, chiefly of British origin. Robert Brown, naturalist on Mathew Flinders **Investigator,** during its Admiralty expedition to Australia in 1801, collected more than 3,000 plant specimens. The first part of his **Prodromus Florae Novae Hollandiae et Insulae Van-Dieman***,* published in 1801, revolutionised botanical classification, and its insights into the

anatomy, physiology and function of Australia's plants stimulated interest in the new science of geography. John Gould studied and painted many of Australia's birds and animals in 1838-40 and Joseph Hooker investigated the flora of Tasmania and in his **Flora Tasmania**, published in 1859, discussed its biogeography in terms of the new theory of natural selection propounded by Charles Darwin. Darwin himself had visited Australia in 1836 as the **Beagle** made its way home from its voyage to South America and the Galapagos Isles.

German-born botanist Baron Ferdinand yon Mueller, who was appointed Victorian Government botanist in 1853, travelled throughout south-eastern Australia developing a formidable collection and knowledge of Australia's flora. He published 800 papers and many books and was left embittered when the task of writing the first **Flora Australiensis** went to eminent British botanist George Bentham. Bentham drew heavily on von Mueller's data, but never visited Australia himself.

Astronomy, the science which was ultimately responsible for Australia's colonisation (the **Endeavour** had journeyed to Tahiti to allow scientific observations of the transit of Venus across the face of the sun in 1796), was also a significant research activity in Australia. Southerly latitudes and clear skies offered a much richer vista of the universe. Sir Thomas Brisbane, Governor of New South Wales in 1821 and who in the same year became president of the Philosophical Society (forerunner of the Royal Society of New South Wales), was a keen amateur astronomer. He brought with him the best available astronomical instruments and two expert astronomers, Carl Rumker and James Dunlop. Brisbane built a small observatory at Government House in Parramatta which rapidly gained an international reputation. Among its achievements was the first observation of Encke's comet in 1822.

John Tebbutt's astronomical observations from 1854 onwards led to the discovery of several more comets, as well as several double stars and variable stars, and several new satellites of Jupiter. From such beginnings, Australia developed a reputation in international astronomy which has been continued in modern times by the achievements of its optical and radio astronomers.

One of Australia's most brilliant scientists, but one who received little recognition in his time, was British-born Lawrence Hargrave, inventor of the box kite, who developed a theory of aeronautics based upon his experiments with kites and model aircraft. He discovered that wings with curved surfaces gave twice the lift of flat wings, and that a tail plane gave added stability to his model aeroplanes. Both principles were of fundamental importance to the development of flight. Hargrave also developed a workable radial rotary airscrew engine which formed the basis for the first engines used in European aircraft in the 20th century.

Henry Sutton, a music shop proprietor, designed a continuous current dynamo as early as 1870, constructed as many as 20 different types of telephone at the same time that Alexander Graham Bell was achieving recognition for his invention of the telephone in America. During the 1870s, Sutton carried out experiments with heavier-than-air materials for flight.

Australia's first university, the University of Sydney, had been founded in 1850, but did not establish a separate science faculty until 1879. Melbourne University was founded in 1853, Adelaide University in 1874, and the University of Tasmania in 1889.

By the late 19th century, Australian science had developed considerable momentum. Royal Societies or Philosophical Societies existed in all the eastern States by 1884, and university researchers were making important contributions to international science and technology, principally in the area of fundamental studies. Horace Lamb, who became the first Professor of Mathematics at Adelaide University a year after it was established in 1874, was later elected a Fellow of the Royal Society for outstanding research into the motion and properties of fluids. Melbourne University chemist, Professor David Masson, was also elected to the Royal Society for his fundamental work on the constitution of atoms and his theory of the dissociation of

electrolytes in water.

The steady expansion of agriculture in Australia confronted the industry with a range of environmental and agronomic problems. Additionally, crops and animals that had been selected for northern hemisphere conditions performed relatively poorly in Australia. The need for scientific study of agriculture was realised, and in 1885, Roseworthy Agricultural College was founded in South Australia to teach the principles of agriculture and to investigate its problems. Victoria's Dookie Agricultural College was founded a year later. N.S.W's Hawkesbury Agricultural College was rounded in 1891; that same year a horticultural college was founded in Victoria.

Australia's geology was very different from that of other countries; there was lively debate over the age of the continent, and the discovery of major mineral deposits during the 1800s provided economic incentive for geological research and exploration. The State governments sponsored geological and mineralogical surveys which, in addition to discovering mineral deposits, also yielded geological, mineralogical and topographical maps upon which renewed mineral exploration in the 20th century was based.

Australia's minerals industry traces its beginnings to the 1797 discovery of coal on the banks of the Hunter River, as well as at Coalcliff 65 km south of Sydney. The mining technology of the day was inadequate to extract the coal; Australia's distinctive geology has continued to pose special problems for mining operations, and throughout the 1800s required the development of innovative mining techniques for important minerals. By the late 1800s, gold, tin, copper, silver, lead and zinc orebodies were being mined, often at considerable depth, where hazards to miners were great. Australia was the world's largest producer of gold, and at Bendigo, novel deep-drilling techniques had been developed which permitted recovery of ore from considerable depths, at a time when most gold mines were still extracting gold from basically alluvial sources. Research for safer and more efficient mining techniques continues today.

Mineral extraction techniques evolved; the bromo-cyanide process for gold extraction was first demonstrated at Kalgoorlie to recover gold from telluride ores in 1899 and the world's most important mineral extraction and separation technique, the flotation process, was first developed on a commercial scale in Australia by Charles Potter, a Melbourne brewer and chemist. Potter's process, patented in 1901, employed a late 18th century discovery that powdered mineral ores particles could be brought to the surface and suspended by attaching to bubbles passed through ore-charged liquids. First used at Broken Hill in 1901, Potter's flotation process initially yielded a collective aggregate of silver, lead and zinc, but later developments, some of them arising from fundamental studies, saw the flotation process progressively refined to the point where lead, zinc and many other commercially important minerals could be floated out selectively.

Science and technology in 20th century Australia

With Federation in 1901, and with the Australian economy evolving rapidly in diversity and complexity, the administration and funding of science in Australia took on a more systematic pattern, chiefly because of the increasing involvement of the new Commonwealth Government. In time, it would become the major sponsor of Australian science and technology, giving it the cohesion and direction that had been absent in the previous century. Australia's traditional reliance upon agricultural and mineral exports saw both government and private industry research focused in these areas, a pattern which was to predominate until recent times.

Australia's fifth university, the University of Queensland, was the first university established in the 20th century, in 1910; Western Australia became the last State to establish a university, the University of Western Australia, in 1913. By the 1980s, Australia had 19 universities - Sydney and Melbourne each have three, Brisbane, Adelaide and Perth each have two, Hobart has one and there are universities in the Australian capital, Canberra, and the major provincial centres of Geelong, Armidale, Townsville, Newcastle and Wollongong.

Australia's universities have made important contributions to international science and technology. In 1907, Professor O. U. Vonwiller of Sydney University showed that amorphous selenium would conduct electricity induced by light, anticipating the development of the modern photocopier. In 1928, E. J. Hartung of Melbourne University showed that the photographic paper darkened when exposed to light because silver chloride decomposed, giving off chlorine and precipitating silver.

In the first half of the 20th century, universities concentrated on their educational role. Their links with industry were oriented mainly towards agriculture and mining, and interaction with manufacturing industry was at a low level.

In 1926, the Commonwealth established the Council for Scientific and Industrial Research (CSIR), progenitor of the Commonwealth Scientific and Industrial Research Organisation. CSIR's early work focused on research for agriculture which, as the economic impetus of great gold rushes of the latter half of the 19th century ebbed, had become the mainstay of the economy. Agriculture was centred on wheat and grazing; wool had been established as a major export the previous century, and after a faltering start, the wheat industry was prospering from the legacy of breeders such as Farrer.

CSIR's early work was constrained by limited resources but gradually it built up individual research programs, and then specialised research divisions, studying animal health and nutrition, soils, economically-significant plants, fisheries, food preservation and transport. No until 1936 did the Australian Government decide to extend CSIR's activities into secondary industry. It proved a timely decision, providing a springboard for the development of industries that strengthened Australia's effort during World War 11.

During the War three new divisions were formed, dealing with dairy research, radiophysics, and lubricants and bearings - the latter became the Division of Tribophysics (surface physics). Some of CSIRO's most significant achievements, even to the modern day, trace back to the wartime establishment of these divisions.

One of the most important developments in CSIR was the establishment of a National Standards Laboratory in 1939 to administer and refine standards of measurement, as well as to calibrate the measurement tools of Australian industry. It underpinned the contribution of manufacturing industry to the war effort.

In the same year, CSIR began a top-secret radar project in a laboratory at Sydney University, which later allowed the deployment of a transportable radar system in the Pacific war theatre.

In 1947, man-made rain fell for the first time in Australia, and probably in the world, when a CSIR aircraft seeded clouds over the Blue Mountains with silver iodide. Research into rainmaking was finally discontinued in 1981 after it was concluded that no useful increase in rain could be produced by cloud seeding, a finding which itself produced controversy.

In the years immediately after the War, a debate arose over potential conflict between CSIR's need for scientific freedom, and the preservation of national security. The Science and Industry Research Act of 1949, which formally established the Commonwealth Scientific and Industrial Research Organisation (CSIRO), resolved the issue by specifically precluding its involvement in secret or classified research of a military nature.

CSIRO's management was now conducted by a small Executive, instead of the council that had guided CSIR. The Executive's first chairman was Ian Clunies Ross (later Sir Ian), whose vision of the potential contribution of scientific research to Australia's development, alloyed with his exceptional skills as an advocate and lobbyist for science, was primary responsible for a

remarkable decade of expansion and diversification of the Organisation from 1949 to 1959.

In 1945, CSIR had established a Division of Radiophysics to study the sun. By the 1950s, CSIRO led the world in radioastronomy, and in 1961 began studies of the radio universe with one of the world's largest radiotelescopes at Parkes, New South Wales. The instrument, which in enhanced form is still in use today, has yielded important discoveries about the evolution of the universe. Among other things, it has located half of the known pulsars - rapidly rotating remnants of stars destroyed by supernovas - and has identified complex organic molecules in space which could have been building blocks for life. From the mid - 1960s, it served as a powerful primary receiver for transmissions from US spacecraft, relaying Mans' first words from the moon, and playing major roles in the dramatic rescue of the astronauts aboard the ill-fated Apollo 13 mission and the tracking of the Giotto space probe to Halley's Comet in 1986. CSIRO's new Australia Telescope, an array of radio antennae incorporating the Parkes radiotelescope, is due to be completed during 1988. It will have equivalent power to a radiotelescope 300 km in diameter, and will be capable of mapping the furthest reaches of the universe.

The Division of Radiophysics has made two outstanding contributions to air navigation technology; firstly with the development of the Distance Measuring Equipment system, based on triangulation with radio beacons, and secondly, with Interscan, a microwave-based landing system that allows aircraft to locate their position in three-dimensional space with great precision under all weather conditions. Interscan allows a choice of widely-varying landing approaches to be chosen, helping to minimise noise pollution and greatly increasing the flexibility and safety of air traffic control. In 1978 the International Civil Aviation Organisation selected Interscan as the international standard for aviation landing systems to serve into the 21st century.

The three decades after World War 11 saw CSIRO establish a reputation for excellence in research in many fields. A huge rabbit plague had developed during the war years, and was having a disastrous effect on the productivity of grazing land. CSIRO imported a virus for the rabbit disease myxomatosis, which after initial failure, took hold in Victoria in 1950 and killed millions of rabbits.

In 1952 CSIRO scientist Alan Walsh developed the atomic absorption spectrometer, a device capable of rapidly analysing the chemical constituents of materials as diverse as mineral samples, human blood or polluted water. Described as the greatest advance in chemical analysis this century, the atomic absorption spectrometer has saved mineral exploration companies millions of dollars by performing in minutes complex chemical analyses that had once taken many days.

So extensive and diverse are CSIRO's research activities that any account of its achievements is necessarily eclectic. Other significant advances in the post-war decades include:

- Partially-stabilized zirconia (PSZ), described as the world's toughest ceramic.;
- A new generation of safe, potent insecticides called insecticidal esters, based upon fundamental studies of the interaction of chemical molecules with insect nerve membranes. Insecticidal esters will not persist in the environment and have very low toxicity to other animals;
- Biological control of skeleton weed during the 1960s, and sirex wood wasp in pine plantations in the 1970s. More recently, a highly successful biological control program against the world's worst water weed, the floating fern **Salvinia**, in Australia, Papua New Guinea and several Asian and African nations. **Salvinia** is expected to be reduced to an insignificant economic problem around the world by the 1990s;
- SIROTEM, a new electromagnetic device which allows hidden sub-surface orebodies to be

detected at depths up to 300 m;

- Advanced satellite image-analysis techniques, which have revolutionised strategic exploration for minerals, allowed large-scale mapping of Australia's environments, and permitted monitoring of the development of crops;
- A computerised system for managing cotton and its pests, based on an understanding of how the crop develops and of the life cycles of pests and their natural predators;
- Several advanced methods of purifying water, based on ion-exchange resins or tiny magnetic beads which selectively remove salts and other impurities;
- Genetically engineered animals. CSIRO produced Australia's first genetically-engineered sheep in 1986. The technique ultimately promises sheep which will grow faster and larger under the influence of an extra growth hormone gene in their cells;
- A vaccine which promotes twin births in sheep, accelerating productivity for the fat lamb industry;
- Genetic engineering of plants. CSIRO produced Australia's first genetically engineered plant in 1985, and is now working to produce genetically engineered cereals;
- A technology for custom-designing computer chips containing more than 100,000 transistors. The technology allows research institutions and industry to design chips for specialised applications in scientific devices or high-technology manufactured goods;

Other Commonwealth instrumentalities, universities and other education institutions, medical research centres, State research bodies and, to a lesser extent, private industry, have provided the warp to CSIRO's weft in the fabric of Australian science and technology. Some of their achievements in recent decades include:

- Development of a new high-efficiency solar cell by the University of NSW, employing a simpler metal-insulator semiconductor system;
- Melbourne University's 'bionic ear', an implant for the totally deaf, which analyses sound and encodes it for detection by the brain;
- A new process for producing ethanol by fermentation, using the bacterium **Zymomonas mobilis**, instead of yeast, developed by the University of NSW;
- The identification and isolation by the Australian Institute of Marine Science of a natural agent that protects corals from damaging ultra-violet radiation. The compound has potential uses in commercial sunscreens, and in weathering-resistant paints and plastics;
- Commercial development and release by a private company, Biotechnology Australia, in 1986 of Australia's first genetically-engineered vaccine for use against lethal diarrhoea in piglets;
- Development by Comalco of a highly durable lightweight aluminium alloy, called 3HA, suitable for use without steel liners in alloy engine blocks, as well as in diverse applications involving high strength aluminium castings;
- A new type of automotive engine, employing an orbital motion, developed by the Perth-based private inventor, entrepreneur and engineer, Ralph Sarich, and developed by his company. The new engine has considerably fewer moving parts than any existing

automotive engine, and delivers equivalent power from a much smaller size. Sarich has also developed a revolutionary new fuel injection system; both inventions are approaching commercial release;

- The Jindalee over-the-horizon radar system, developed by the Defence Science and Technology Organisation, which bounces transmission off the ionosphere, allowing targets hundreds of kilometres off Australia's north-west coast to be detected;
- Synroc, a synthetic composite mineral for the safe, long-term immobilisation and storage of radioactive wastes, developed by the Australian National University;

Medical science in the 20th century

At the time of Federation, the States ceded many functions to the Commonwealth, but preserved their responsibility for the health of their communities. As a result, many of Australia's medical research institutions are administered by their respective States, or in conjunction with the Commonwealth. However, most derive a significant part of their research funding from the Commonwealth, principally from the National Health and Medical Research Council, or from various private foundations such as the National Heart Foundation and the various State Anti-Cancer Councils. Under this system, medical research has flourished and Australia enjoys an international reputation for excellence in many fields. Some of the important achievements of Australian medical research include:

- Australian researcher Priscilla Kincaid Smith was one of the first to recognise the link between indiscriminate use of analgesics and a high incidence of kidney damage;
- Although the first birth resulting from in-vitro fertilisation occurred in England, Australia has become pre-eminent in the treatment of human infertility and has a higher success rate than any other country in the world, due largely to the pioneering work of Professor Carl Wood and his associates at Monash University;
- Researchers from Melbourne University and the Royal Children's Hospital in the early 1970s established that rotaviruses were the most important single agent responsible for infantile diarrhoea in both developed and developing nations. Research is in progress to develop a genetically engineered vaccine;
- In collaboration with the Australian National University, CSIRO has determined the structure of one of the key proteins of the influenza virus, and is working with ANU to develop a drug to treat influenza, as well as a synthetic vaccine;
- The Walter and Eliza Hall Institute's recent development of a prototype vaccine against malaria, from basic studies of the antigenic components of the protein coat of the malaria parasite. An estimated 300 million people around the world suffer from malaria, and an effective vaccine would represent one of the most important developments of 20th century medical science;
- Adelaide University's development, via genetic engineering, of a prototype oral vaccine against cholera and typhoid, two other major diseases in developing nations;
- A synthetic human growth hormone, developed by Sydney's Garvan Institute of Medical Research, the University of N.S.W. School of Biotechnology, and California Biotechnology, which could provide a safe treatment for hereditary dwarfism.

The future of Australian science and technology

The future of Australian science and technology appears bright. The nation has no shortage of original thinkers, as attested to by the volume of Australian research papers contributed to the international scientific literature, particularly in areas of fundamental knowledge. That very strength, however, hints at a chronic problem - the low rate at which original ideas are translated into practical applications, or into marketable products or processes that can be marketed within Australia and overseas.

The underlying reasons are historic; most Australian companies were small by overseas standards and could not sustain their own in-house research programs. In the post-War years, Commonwealth Governments actively encouraged multi-national companies to establish subsidiaries in Australia, as a means of diversifying the economy and providing employment, but a penalty in this approach was that such companies were able to rely upon imported technology and ideas from their overseas parents. Some even absorbed progressive local companies, with adverse effect on the level of private research and development.

In the past three decades, the level of privately sponsored research and development declined to one of the lowest levels of any Western nation. There has been little economic pressure to innovate or to maintain technological parity with overseas manufacturers. As a consequence, privately sponsored research stagnated and declined. Until quite recently, Australia's need for foreign exchange has been satisfied by international markets for wheat, wool and minerals, and manufacturing industry fell behind its counterparts in Europe and the United States - not only in its level of involvement in export markets, but in the production technologies it was employing, so that its efficiency declined as well. By the late 1970s, with international export markets for agricultural produce and raw materials declining, and dominated increasingly by manufactured, high-technology goods, the imbalance in Australia's economy was increasingly apparent, and the need to restructure and reorient science and technology towards the task of improving manufacturing industry's performance had become imperative.

Historians may argue that Australia failed to heed the first major warning of the vulnerability of its economy to changes in the marketplace. In the 1950s a new generation of synthetic fibres began to erode markets that had traditionally been dominated by wool. In an intensive research effort from that time onwards, CSIRO studied the biological, biochemical and physical properties of wool and produced innovations in wool processing and wool treatment, such as permanent-pleat wool garments, shrinkproof wool fabrics, and Self-twist spinning - a faster and more economical spinning technique which revolutionised wool spinning around the world. CSIRO also developed cheaper methods of processing wool and evolved a marketing system based on objective measurement of wool's properties, which had traditionally been assessed by eye and hand. This intensive and comprehensive research and development program maintained wool's reputation as the premier fashion fibre in world markets, where the industry might easily have foundered in the 1960s, with disastrous effect upon the Australian economy.

In the past few years Australian research institutions have begun to pay increasing attention to the commercialisation of their research. CSIRO, a number of universities, and private medical research centres have individually or jointly established their own commercial companies. Medicine, veterinary science and agriculture, the historical strengths in Australian research, seem destined to play an important role in Australia's economic future.

Australian scientists and technologists are contributing to the spectacular international growth of information technology, through the development of innovative computer hardware and software, networking systems, and advanced information storage and retrieval systems. Information technology is a growth industry that provides marketable commodities in its own right, but its greater contribution may be as a catalyst for the advancement of existing industries in Australia, which are showing encouraging signs of exploiting technology to improve their production efficiency, and to develop innovative products for local and export markets. It also provides a

means of gaining access to a vast pool of information and ideas held in international data bases and overseas laboratories. Australia's substantial and continuing contribution to this pool has given it reciprocal rights to employ the information to its own advantage; the nation's prosperity during the next two centuries will be rounded on the sharing of information with the international community, its own continuing intellectual vigour and a resurgence of the enterprise and industrial dynamism that characterised its earlier years.

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